

Green Technology and its Benefits - A Review

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ABSTRACT:

The field of “green technology” includes a continuously evolving group of methods and materials, from techniques for generating energy to non-toxic cleaning products. It is the application of environmental science to conserve the natural environment and resources. Green energy is otherwise called as renewable energy, which includes solar power, wind power, geothermal power, hydroelectric power, biomass and biofuel. The great threat to our earth is global warming or green house effect, it is the increase in the average temperature of the earth’s near-surface and oceans since the mid-20th century and it is continuing. The causes of recent warming is that the increase in atmospheric greenhouse gases like CO₂, methane, tropospheric ozone, CFCs and nitrous oxide due to human activity has caused most of the warming. The usage of non-renewable sources for energy generation is one of the main causes for global warming but renewable sources are eco-friendly, non-polluting and do not produce green house gases. This article gives information about the field of green energy and its benefits.

Keywords: Green energy, Green nanotechnology, Biofuels

INTRODUCTION

Green technology or environmental technology or clean technology is the technology applied to conserve the natural environment and resources, and to curb the negative impacts of human involvement. Sustainable development is the core of environmental technologies it should be socially equitable, economically viable, and environmentally sound [1]. Green technology was initiated in the early 1970s when environmental movement drew attention to the development of alternative energy sources and conservation measures due to a trend in the enactment of legislation and regulations to control the effects of industrial pollution. Since then, the effects of humans and technology on our natural environment have become a topic of much research in many areas of science, engineering and industry [2].

GREEN ENGINEERING

WASTE REDUCTION

Waste reduction measures are justified on the basis of financial analysis without concern for the environmental benefits. Economic benefits result from reduced budgets for material, waste handling equipment and labor. Efficient material usage also results in other intangible benefits such as workers awareness and more accurate levels of material accounting.

MATERIAL MANAGEMENT

Material management involves recovery of materials for furnished components for reuse in the highest value-added application. In addition, it involves making a material useful while minimizing the amount of added processing needed to effect recovery. It includes following three categories,

Design for recycling (DFR) – it applies to the cost-effective reuse of materials and whole compounds.

Design for disassembly (DFD) – it includes use of assembly methods and configurations that allow for cost-effective separation and recovery of reusable components and materials.

Toxics management –it is used in elimination or control of toxic materials that are an intrinsic part of the product. E.g., cadmium in batteries or lead solder in printed boards. These materials pose an increasing threat to public health land and ground water contamination after eventual disposal [3].

PREVENTION OF POLLUTION

The goal of pollution prevention is to eliminate the use of manufacturing processes that generate pollution. This can be achieved by either, re-design of processes to eliminate the production of harmful by-products, or, the design of products to eliminate the need for these processes that generate harmful by-products. These internalized methods differ from pollution controls, a term that refers to the treatment of harmful by-products after they have been created. This is also commonly known as the “end-of-pipe” (EOP) solution.

PRODUCT ENHANCEMENT

In many cases, the function of a product can be significantly enhanced by the inclusion of features that result in less waste and pollution during use throughout its operating life. Ideally, the application of green engineering principles will lead to an entirely new perspective on engineering in general, with underlying goal of meeting the complex material needs of society in sustainable harmony with the life-giving forces of our natural world [4, 5].

GREEN TECHNOLOGY AREAS

Green building: Green building encompasses everything from the choice of building materials to where a building is located.

Environmentally preferred purchasing: It involves the search for products whose contents and methods of

production have the smallest possible impact on the environment, and mandates that this be the preferred products for government purchasing.

Green chemistry: The invention, design and application of chemical products and processes to reduce or to eliminate the use and generation of hazardous substances.

Green nanotechnology: It involves the manipulation of materials at the scale of the nanometer, one billionth of a meter. Some scientists believe that mastery of this subject is forthcoming that will transform the way that everything in the world is manufactured. "Green nanotechnology" is the application of green chemistry and green engineering principles to this field [6].

METHODS

SOLAR POWER

Sunlight is the source of most renewable energy power, either directly or indirectly. The sun can be harnessed to produce solar energy - electricity for heating, cooling, and lighting homes, offices, entertainment complexes, airports, and a variety of other industrial structures [7].

MODERN SOLAR POWER PROJECT

The Solar Mission Project's focus is a solar tower powered by physics. Originally based on a concept called the solar chimney - a name that was abandoned because of the negative environmental connotations of a "chimney" - the hollow tower would be 1 kilometer tall, making it the tallest manmade construct in the world (a title currently ascribed to Canada's CN Tower, but claims made to that title by any modern building are sketchy at best) [8]. The tower would be surrounded by a 25,000-acre, transparent circular skirt of greenhouse panels, which would warm the air trapped underneath to about 95 degrees Fahrenheit above the ambient temperature. The cool air at the top of the 400-feet-in-diameter tower would then draw the hot air up from ground level at a speed of roughly 35 miles per hour, which in turn would drive the 32 turbines around the bottom half of the tower. The turbines provide around 200 megawatts of electricity. The tower's energy output is approximately equivalent to a small nuclear power station, and could power up to 200,000 average homes, as well as eliminate the production of up to 900,000 metric tons (830,000 U.S. tons) of greenhouse gasses. These facts make it a highly attractive alternative power source, to the point that the Australian federal government awarded the Solar Mission Project "Major Project Facilitation Status," which means the government considers the project to be of major public interest and has given it moral backing. The Solar Mission Project is an attractive alternative power source proposition because it can achieve the same goal as a windmill farm without depending on the wind to generate power. Ostensibly, the tower can run 24 hours a day using

stored heat. The same major drawback of windmill farms - the clamor of locals who say the power sources will be an eyesore to whatever region they are proposed to be built in - is shared by the solar tower on a somewhat larger scale. The kilometer-tall construct would be able to be seen from up to 80 miles away at ground level, and would even be visible from space. However, Enviro Mission has picked a fairly remote location that has great exposure to sunlight: The Buronga district of the Wentworth Shire in New South Wales, Australia.

WIND POWER

Heat from the sun also produces wind, whose energy is captured by wind turbines and turned into electricity capable of powering entire towns [9]. The Earth is unevenly heated by the sun resulting in the poles receiving less energy from the sun than the equator does. Also, the dry land heats up (and cools down) more quickly than the seas do. The differential heating drives a global atmospheric convection system reaching from the Earth's surface to the stratosphere which acts as a virtual ceiling. Most of the energy stored in these wind movements can be found at high altitudes where continuous wind speeds of over 160 km/h (100 mph) occur. Eventually, the wind energy is converted through friction into diffuse heat throughout the Earth's surface and the atmosphere. The total amount of economically extractable power available from the wind is considerably more than present human power use from all sources. [10].

DISTRIBUTION OF WIND SPEED

The strength of wind varies, and an average value for a given location does not alone indicate the amount of energy a wind turbine could produce there. To assess the frequency of wind speeds at a particular location, a probability distribution function is often fit to the observed data. Different locations will have different wind speed distributions. The Rayleigh model closely mirrors the actual distribution of hourly wind speeds at many locations. Because so much power is generated by higher wind speed, much of the energy comes in short bursts. The 2002 Lee Ranch sample is telling [11]. Half of the energy available arrived in just 15% of the operating time. The consequence is that wind energy from a particular turbine or wind farm does not have as consistent an output as fuel-fired power plants; utilities that use wind power provide power from starting existing generation for times when the wind is weak thus wind power is primarily a fuel saver rather than a capacity saver. Making wind power more consistent requires that various existing technologies and methods be extended in particular the use of stronger inter regional transmission to link widely distributed wind farms since the average variability is much less; the use of hydro storage and demand-side energy management [12].

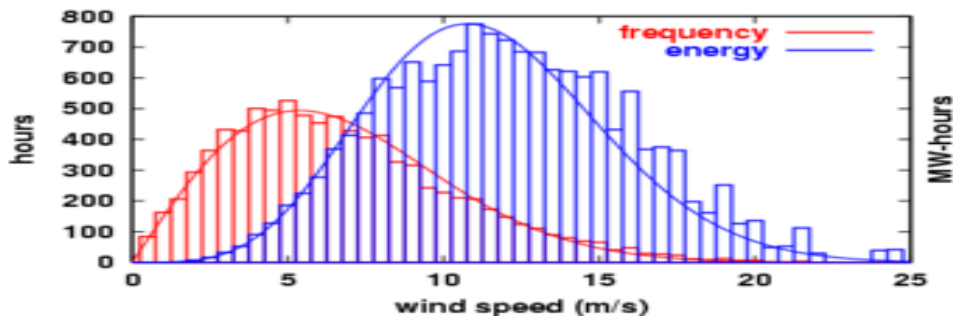


Fig1: Rayleigh Model.

HYDROELECTRIC POWER

Hydroelectric power is produced from streams, rivers, and waterfalls that flow downhill, their tremendous power turning large turbines that convert the flow to electricity. Industrialized nations have already developed most of the world's large hydroelectric resources, but small-scale technologies are being developed that will provide additional localized power in the future. Water has long been used as a source of energy, beginning with the Greeks use of water wheels over 2,000 years ago. For over a century, hydropower has been used to generate electricity from falling water. Hydroelectric power stems from the process of using water's energy as it flows from higher to lower elevation, rotating hydraulic turbines to create electricity. Tidal power, although not widely used, can also generate hydroelectricity by utilizing the same principle. Hydropower is considered to be a clean, renewable source of energy, emitting a very low level of greenhouse gases when compared to fossil fuels. It has a low operating cost once installed and can be highly automated. An additional benefit is that the power is generally available on demand since the flow of water can be controlled. Using hydroelectric power also has disadvantages. Dams can block fish passage to spawning grounds or to the ocean, although many plants now have measures in place to help reduce this impact. The diversion of water can impact stream flow, or even cause a river channel to dry out, degrading both aquatic and streamside habitats. Hydroelectric plants can also have an impact on water quality by lowering the amount of dissolved oxygen in the water. In the reservoir, sediments and nutrients can be trapped and the lack of water flow can create a situation for undesirable growth and the spread of algae and aquatic weeds [13]. One incentive for hydroelectric facilities to help mitigate their overall impact on the environment is through green power certification. The Low Impact Hydropower Institute (LIHI) created a voluntary certification program whereby facilities are classified as low impact after passing a series of tests that demonstrate minimal impact. In 2007, less than 30 facilities in the U.S. had that distinction. Certification programs, such as the one set by the LIHI, can benefit

hydropower efforts by attracting consumers concerned about energy source impacts. While the use of water to produce electricity is an attractive alternative to fossil fuels, the technology must still overcome obstacles related to space requirements, building costs, environmental impacts, and the displacement of people. However, within the U.S., possible locations for new hydropower projects are beginning to diminish [14].

GEOHERMAL ENERGY

Geothermal energy taps the Earth's internal heat in the form of steam for a variety of uses, including electric power production, and the heating and cooling of buildings. Some new systems are in development for harvesting even more power by injecting water back into underground heat sources to produce more steam. Geothermal ("earth heat") energy has tremendous potential for producing electricity. About 8,000 megawatts (MW) of geothermal electricity are currently produced around the world, including about 2,800 MW of capacity in the United States. Today's technology produces electricity from hydrothermal (hot water/steam) resources. In the future, we may be able to use the heat of the deep, hot, dry rock formations of Earth's crust, and possibly the even deeper, almost unlimited energy in Earth's magma. Two basic types of geothermal power plants are used today: steam and binary.

Steam plants use very hot (more than 300° F) steam and hot water resources (as found at The Geysers plants in northern California—the largest geothermal electricity producer in the world). The steam either comes directly from the resource, or the very hot, high-pressure water is depressurized ("flashed") to produce steam. The steam then turns turbines, which drive generators that generate electricity. The only significant emission from these plants is steam (water vapor). Minute amounts of carbon dioxide, nitric oxide, and sulfur are emitted, but almost 50 times less than at traditional, fossil-fuel power plants. Energy produced this way currently costs about 4-6 cents per kWh.

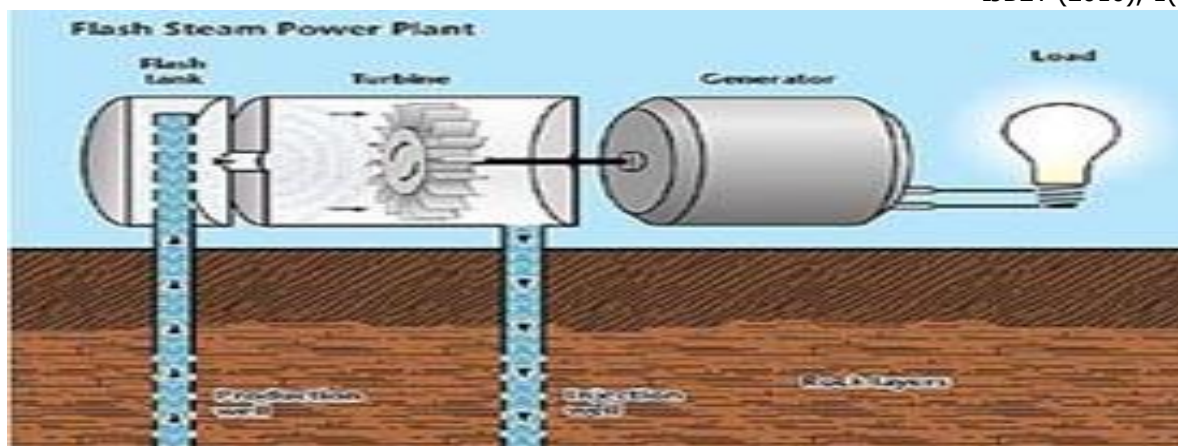


Fig2: Binary Plants

Binary plants use lower-temperature, but much more common, hot water resources (100° F – 300° F). The hot water is passed through a heat exchanger in conjunction with a secondary (hence, "binary plant") fluid with a lower boiling point (usually a hydrocarbon such as isobutane or isopentane). The secondary fluid vaporizes, which turns the turbines, which drive the generators. The remaining secondary fluid is simply recycled through the heat exchanger. The geothermal fluid is condensed and returned to the reservoir. Because binary plants use a self-contained cycle, nothing is emitted. Energy produced by binary plants currently costs about 5 to 8 cents per kWh. Because these lower-temperature reservoirs are far more common, binary plants are the more prevalent. Although geothermal power plants have many features in common with more traditional power plants, they also pose special challenges: non-condensable gases and minerals in the geothermal fluid, need for a greater amount of heat rejection, use of hydrocarbon fluids, and lack of cool water to cause condensation. NREL researchers are therefore working on new technologies that will improve heat-exchange efficiency, lower the equipment-damaging effects of the sometimes corrosive geothermal fluid, and improve the plant's condensing capability. This research is making geothermal plants more efficient, thereby bringing down the cost of geothermal electricity. These new technologies can also be applied to conventional power plants [15].

BIOMASS

Organic plant matter, known as biomass, can be burned, gasified, fermented, or otherwise processed to produce electricity, heat and biofuels for transportation. Bioenergy is another term for energy that is produced from biomass for any of these purposes. Trees, grasses, agricultural crops, and other biological materials are collectively known as biomass. Many people probably associate biomass with the manufacture of alternative fuels—ethanol and

biodiesel. But here we're talking about how wood waste, biogases, and even the scraps in your garbage—yard waste and paper that can't be recycled into new paper products—potentially can be used as fuel in power plants (to make electricity) rather than taking up space in a landfill. Using biomass to produce power is called "biopower". In the southeastern United States, as a matter of fact, biomass technology is already leading the region's renewable power potential. Additionally, biomass—because it's composed of decomposing vegetation—contains carbon that it will release when it's burned. But because the tree in your backyard, for instance, produces new carbon-eating leaves every year to replace the ones you've raked up and sent to the power plant, the level of carbon in the atmosphere remains "carbon neutral" when biomass rather than coal is burned as a fuel. Furthermore, if trees are planted for the sole purpose of producing biopower, then the level of carbon in the atmosphere could be lowered to a level below what it originally was. In this case, biopower from these trees can potentially be "carbon negative" [16].

BIOFUELS

The U.S. Department of Energy (DOE) defines biofuel as a fuel, such as ethanol, biodiesel, or methane, produced from renewable resources, especially plant biomass and treated municipal and industrial wastes. Biofuels are considered neutral with respect to the emission of carbon dioxide because the carbon dioxide given off by burning them is balanced by the carbon dioxide absorbed by the plants that are grown to produce them. Depending on the method of production, biofuels can also be carbon negative. The use of biofuels as an additive to petroleum-based fuels can also result in cleaner burning with less emission of carbon monoxide and particulates.

Types of biofuels:

Biodiesel: Made by processing vegetable oils, waste cooking oils, and other fats and is also used either in

pure form or as an additive to petroleum-based diesel fuel. Biodiesel can also be made from algae and other non-traditional oily feed stocks.

Biogas: A mixture of methane and carbon dioxide produced by the anaerobic decomposition of organic matter such as sewage and municipal wastes by bacteria. It is used especially in the generation of hot water and electricity.

Ethanol: Produced by fermenting the sugars in biomass materials such as corn and agricultural/plant residues. Ethanol is used in internal-combustion engines either in pure form or more often as a gasoline additive. "E85" gasoline blend that is 85% ethanol and 15% gasoline is a popular fuel for some vehicles that have made an inexpensive conversion to accommodate the different fuel. "E10" which is also popular in some states requires no conversion and can be used in any vehicle.

Cellulosic ethanol: While ethanol is typically produced from the starch contained in grains such as corn, it can also be produced from plant matter containing cellulose. Cellulose is the main component of plant cell walls and is the most common organic compound on earth. Cellulose is made up of starch and sugars that can be used to make ethanol—but first it must be broken down which can prove difficult. Yet, making ethanol from cellulose dramatically expands the types and amount of available material for ethanol production. This includes many materials now regarded as wastes requiring disposal, as well as corn stalks, rice straw and wood chips, or "energy crops" of fast-growing trees and grasses [17].

Modern technology in biofuel production: Many biofuels found its feasible source as algae in recent years, so scientists are working to substitute the algal source in the place of few others for biofuel production. The record oil price increases since 2003, competing demands between foods and other biofuel sources and the world food crisis have ignited interest in alga culture (farming algae) for making vegetable oil, biodiesel, bioethanol, biogas line, bioethanol, biobutanol and other biofuels. Among algal fuels' attractive characteristics: they do not affect fresh water resources [18], can be produced using ocean and wastewater, and are biodegradable and relatively harmless to the environment if spilled [19, 20, 21]. Algae cost more per pound yet can yield over 30 times more energy per acre than other, second-generation biofuel crops. One biofuels company has claimed that algae can produce more oil in an area the size of a two-car garage than an football field of soybeans, because almost the entire algal organism can use sunlight to produce lipids, or oil [22]. The United States Department of Energy estimates that if algae fuel replaced all the petroleum fuel in the United States, it would require 15,000 square miles (40,000 square kilometers), which is a few thousand square miles larger than Maryland, or 1.3 Belgium [23]. This is less

than 1/7th the area of corn harvested in the United States in 2000 [24, 25]. As of 2008, such fuels remain too expensive to replace other commercially available fuels, with the cost of various algae species typically between US\$5–10 per kg dry weight. But several companies and government agencies are funding efforts to reduce capital and operating costs and make algae oil production commercially viable [26].

CONCLUSION

World nations are still not sowing much interest on renewable sources as it requires high capital investments and also the non-renewable sources have high efficiency in energy production. The bar graph is showing the projections of both renewable and non-renewable sources for the electricity generation (in trillion kilowatt-hours on x-axis) from the year 2005 to 2030 (on y-axis).

The graph in Fig.3 clearly shows that the renewable energy will not play a predominant role in the electricity generation for upcoming two decades because the projection shows that the future is waiting to tap the all the non-renewable energies from the earth. The paradox is not only that earth is going to lose its non-renewable sources but also it would leave our future in a great threat of global warming and doubtlessly it taking our earth to a dead end of all lives. Every nation should realize the benefits of renewable sources and it should be slowly replace all the non-renewable sources in future. However, it may requires high capital investments but they are permanent, non-polluting, eco-friendly, inexhaustible, available throughout the world, very flexible, maintenance cost is very low and viable source.

All renewable sources should be utilized in sufficient amount because some sources may not fulfill our requirements as they are nature dependent, like solar power, which may fails during nights, rainy and cloudy days. During such occasion we can switch over to other sources like wind power, geothermal, biomass, etc. On seeing our future threats like global warming we should neglect the considerations on capital investments for tapping renewable sources. In spite of many researches scientists are feeling better about the usage of biofuels, which requires minimum investment and there is no possibility of failure at any cast. It has the capability of replacing the usage of all petrochemical products in future. The aim of all biofuels is to be carbon neutral. They reduce greenhouse gas emissions when compared to conventional transport fuels. In reality, biofuels are not carbon neutral simply because it requires energy to grow the crops and convert them into fuel. The amount of fuel used during this production does have a large impact on the overall savings achieved by biofuels.

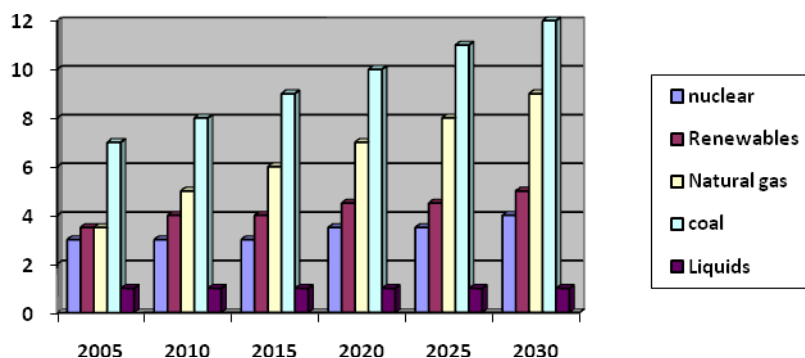


Fig3: Renewable and Non- Renewable resources in electricity generation.

However, biofuels still prove to be substantially more environmentally friendly than their alternatives. In fact, according to a technique called Life Cycle Analysis (LCA) first generation biofuels can save up to 60% of carbon emissions compared to fossil fuels. Second generation biofuels offer carbon emission savings up to 80%. This article indicates the importance of green-technology to the human society.

REFERENCES

- [1] Green technologies definition- [http://en.wikipedia.org/green technology](http://en.wikipedia.org/green%20technology)
- [2] Green products by design: choices for a cleaner Environment, September 1992. OTAE541. <http://www.fas.org/ota/reports/9221.pdf>
- [3] Life Cycle Assessment: Inventory Guidelines and Principles, EPA/600/R92/245, Risk Reduction Research Laboratory Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, OH. February 1993. <http://www.epa.gov/NRMRL/lcaccess/lca101.html>
- [4] Reijnders, L. Environmentally Improved Production Processes and Products: An Introduction. Kluwer Academic Publishing, New York, 1996.
- [5] Altung, L. Manufacturing Engineering Processes, 2nd edition, Marcel Decker, New York, 1994.
- [6] Green technology- <http://www.green-technology.org/what.htm>.
- [7] American council on renewable energy- [http://www.acore.org/what is renewable energy](http://www.acore.org/what%20is%20renewable%20energy).
- [8] Solar Power Project- <http://www.tallestbuildingintheworld.com>.
- [9] Where does the wind come from and how much is there - Calverton Energy Conference, Bath 24th Oct 2008. <http://www.claverton-energy.com/where-does-the-wind-come-from-and-how-much-is-there.html>
- [10] Wind Power- [http://www.mapping the global wind power resource](http://www.mapping%20the%20global%20wind%20power%20resource).
- [11] Common Affordable and Renewable Electricity Supply for Europe- Calverton Energy Conference, Bath, Oct 24th 2008. <http://www.claverton-energy.com/common-affordable-and-renewable-electricity-supply-for-europe-and-its-neighbourhood.html>
- [12] Botkin Daniel B. and Edward A. Keller. Environmental Science: Earth as a Living Planet, Fourth ed., Wiley: 2003.
- [13] Wind & Hydropower Technologies Program: Hydropower Technologies from the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy, August 2005. <http://www.enviroliteracy.org/article.php/59.html>
- [14] National renewable energy Laboratory, U.S.A, <http://www.nrel.gov/geothermal/geoelectricity.html>.
- [15] ACORE Biomass Council and Green: Your Place in the New Energy Revolution, Palgrave Macmillan, 2008. http://www.acore.org/what_is_renewable_energy/biomass
- [16] Renewable Fuels Association, American Heritage Science Dictionary. The Methane Digester for Biogas. National Biodiesel Board. http://www.acore.org/what_is_renewable_energy/biofuel
- [17] Cornell Clayton B. (2008). First Algae Biodiesel Plant Goes Online. Retrieved 2008-06-10. <http://gas2.org/2008/03/29/first-algae-biodiesel-plant-goes-online-april-1-2008/>
- [18] Green Dream' Backed by MPs. Eastern Daily Press (January 2003). January 2003. http://www.globeco.co.uk/Biodiesel_news_0007.html Retrieved 2008-06-10.
- [19] Friends of Ethanol.com biodegradable ethanol. <http://www.friendsofethanol.com/facts.html>
- [20] Low Cost Algae Production System Introduced. Energy- Arizona. 2007-08-28. http://www.energy-arizona.org/archive/200708280001_low_cost_algae_production_system_introduced.php. Retrieved 2008-06-10.
- [21] Why Algae. Solix Biofuels. Retrieved 2008-06-11. http://en.wikipedia.org/wiki/Algae_fuel
- [22] Hartman, Eviana - A Promising Oil Alternative: Algae Energy. <http://www.washingtonpost.com/wp-dyn/content/article/2008/01/03/AR2008010303907.html>

- [23] Major Crops Grown in the United States". U.S. Environmental Protection Agency.
<http://www.epa.gov/oecaagct/ag101/cropmajor.html>
- [24] Dyer, Gwynne, A replacement for oil. The Chatham Daily News. Retrieved 2008-06-18.
http://en.wikipedia.org/wiki/Algae_fuel
- [25] Briggs Michael. Widescale Biodiesel Production from Algae" UNH Biodiesel Group.
<http://www.energybulletin.net/node/2364>.
- [26] <http://www.oilgae.com/algae/oil/extract/extract.html>.